SMART BOOST CONVERTER FOR DC ENERGY SOURCE APPLICATION

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"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelro Degree of Eletrical Engineering (Power System)"

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ABSTRACT

Basically this project is about the operation of step-up dc-dc boost converter for DC energy source application. The objective of this project is to practice the application of boost converter and DC source energy. It also have it's purpose in producing a simple control method for maximum power protection by employing a step-up dc-dc boost converter voltage to a certain value and set the limit voltage for the overvoltage protection system application and load protection. The DC source energy application can be obtain from voltage multiplier as power supply circuit. By using the basic principle, we will build the model and get the simulation for the circuit. In other way to generally explain the operation is the boost converter has functioning switch which had to produce the step-up voltage according to the correct design, the voltage will be the input for the overvoltage protection circuit which is used to protect the load. This circuit has variable voltage setting which can be set as the cut-off voltage to stop the excess voltage from damaging the load or equipment. LED power saving are implement as the load for the DC source energy and also have economical purposes in saving power consumption.

ABSTRAK

Projek ini merangkumi operasi penaikan voltan terus dalam aplikasi sumber tenaga voltan terus.Tujuan projek ini adalah pengaplikasian penukar arus terus dan punca tenaga arus terus. Ia juga merupakan salah satu cara menghasilkan satu kawalan ringkas untuk melindungi litar dari kesan operasi kuasa maksimum dengan menetapkan voltan 'boost converter' pada nilai voltan tertentu dan voltan tersebut ditetapkan pada satu nilai supaya dapat dikesan oleh aplikasi alat perlindungan voltan tinggi untuk melindungi beban elektrik tertentu.Secara ringkasnya, litar penaikkan voltan yg akan menaikkan voltan pada suatu nilai yg telah ditetapkan dengan menggunakan litar rekaan yg betul.Voltan keluar dari litar tadi akan menjadi punca kepada litar perlindungan voltan tinggi dan akan memastikan operasi pengeluaran voltan tidak melebihi voltan yang sepatutnya.

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CHAPTER 1

INTRODUCTION

1.1 Background

A boost converter (step-up converter) is a power converter with an output DC voltage greater than its input DC voltage. It is a class of switching-mode power supply (SMPS) containing at least two semiconductor switches, a diode and a transistor and at least one energy storage element. Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple. Power can also come from DC sources such as batteries, solar panels, rectifiers, and DC generators. A process that changes one DC voltage to a different DC voltage is called DC to DC conversion.

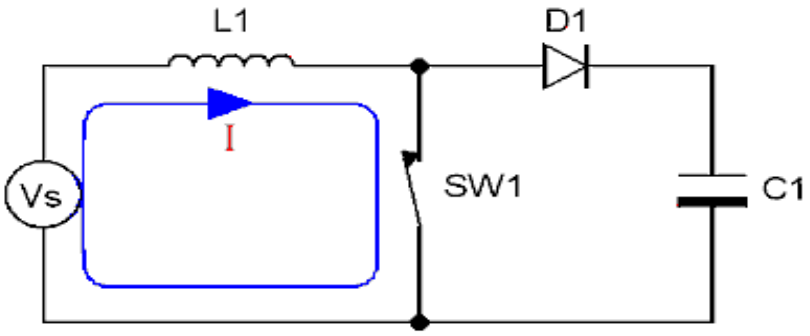

Figure 1.0: The boost converter circuit when the switch is close

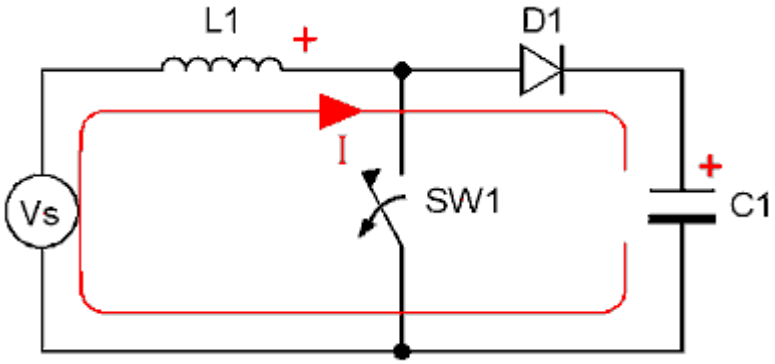

Figure 1.1: The boost converter circuit when the switch is open

The main part that drives the boost converter is the tendency of an inductor to resist changes in current. When being charged it acts as a load and absorbs energy somewhat like a resistor, when being discharged, it acts as an energy source like a battery. The voltage it produces during the discharge phase is related to the rate of change of current, and not to the original charging voltage, thus allowing different

input and output voltages. The basic principle of a Boost converter consists in 2 distinct states (see figure 1.4):

- In the On-state, the switch S (see figure 1.3) is closed, resulting in an increase in the inductor current;
- In the Off-state, the switch is open and the only path offered to inductor current is through the flyback diode D, the capacitor C and the load R. This result in transferring the energy accumulated during the On-state into the capacitor.
- The input current is the same as the inductor current as can be seen in figure 2. So it is not discontinuous as in the buck converter and the requirements on the input filter are relaxed compared to a buck converter.

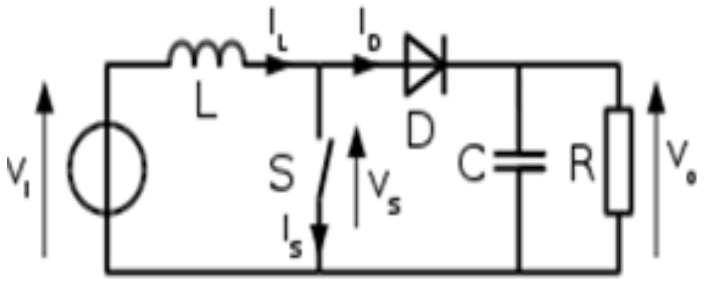

Figure 1.2: The schematic of current and voltage for boost converter

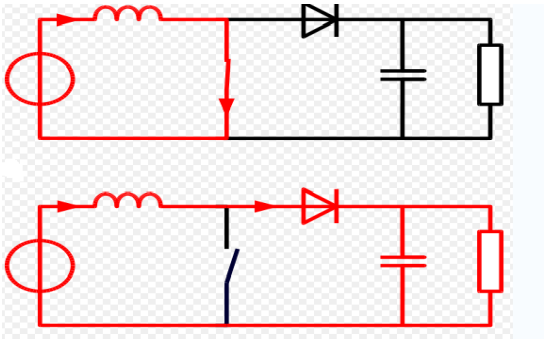

Figure 1.3: The two configurations of a boost converter, depending on the state of the switch S.

Boost converter already been used widely either in electronic for small component with small scale of step-up voltage or mechanical and automotive engineering for its' specialty of converting the voltage to a larger voltage, for example, the Toyota Prius HEV contains a motor which utilizes voltages of approximately 500 V. Without a boost converter, the Prius would need nearly 417 cells to power the motor. However, a Prius actually uses only 168 cells and boosts the battery voltage from 202 V to 500 V.

1.2 Voltage multiplier

A voltage multiplier is an electrical circuit that converts AC electrical power from a lower voltage to a higher DC voltage by means of capacitors and diodes combined into a network.

Voltage multipliers can be used to generate bias voltages of a few volts or tens of volts or millions of volts for purposes such as high-energy physics experiments and lightning safety testing. The most common type of voltage multiplier is the half-wave and full wave series multiplier, also called the Villard cascade (but actually invented by Heinrich Greinacher). Such a circuit is shown opposite.

Voltage multipliers may be classified as voltage doublers, triplers, or quadruplers. The classification depends on the ratio of the output voltage to the input voltage. For example, a voltage multiplier that increases the peak input voltage twice is called a voltage doubler. Voltage multipliers increase voltages through the use of series-aiding voltage sources. This can be compared to the connection of dry cells (batteries) in series. The input could be directly from the power source or line voltage. This, of course, does not isolate the equipment from the line and creates a potentially hazardous condition. Most military equipments use transformers to minimize this hazard.

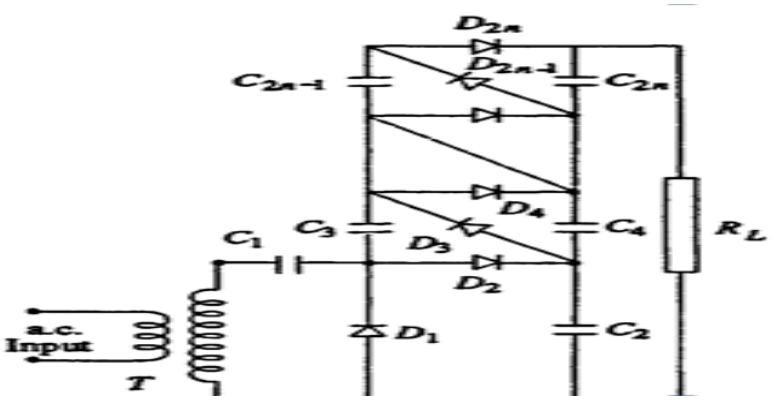

Figure 1.4: Example Cockcroft-walton voltage multiplier circuit

1.3 LED Power Saving

LEDs are based on the semiconductor diode. When the diode is forward biased in switched on state, electrons are able to recombine with holes and energy is released in the form of light. This effect is called electroluminescence and the color of the light is determined by the energy gap of the semiconductor. The LED is usually small in area (less than 1 mm^2) with integrated optical components to shape its radiation pattern and assist in reflection.

LEDs present many advantages over traditional light sources including lower energy consumption, longer lifetime, improved robustness, smaller size and faster

switching. However, they are relatively expensive and require more precise current and heat management than traditional light sources.

Applications of LEDs are diverse. They are used as low-energy indicators but also for replacements for traditional light sources in general lighting, automotive lighting and traffic signals. The compact size of LEDs has allowed new text and video displays and sensors to be developed, while their high switching rates are useful in communications technology.

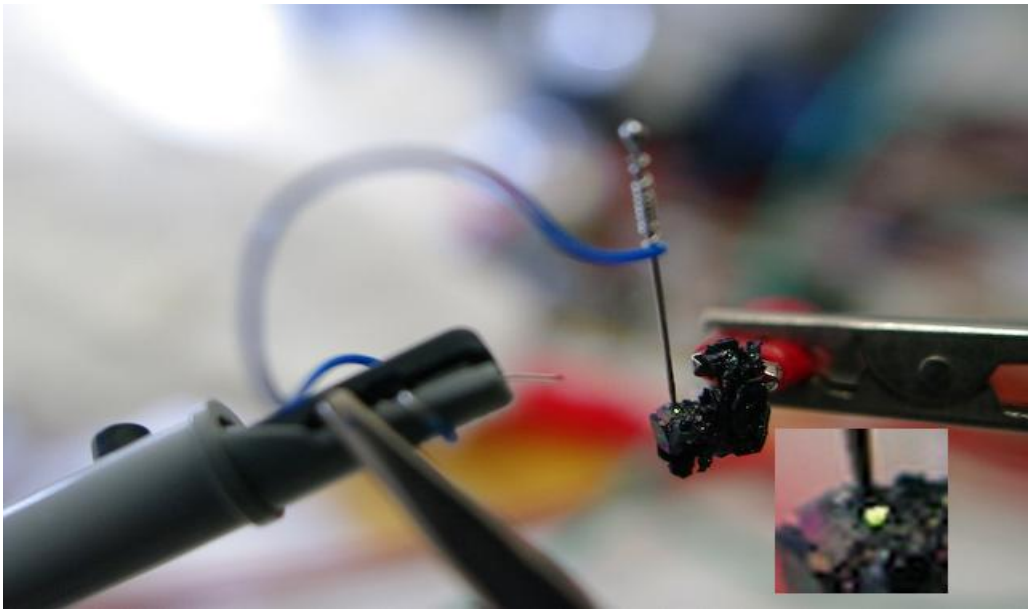

Figure 1.5 : Green electroluminescence from a point contact on a crystal of SiC recreates H. J. Round's original experiment from 1907.

1.4 Objective of Project

The objective of this project is to:

i. Build a voltage multiplier that capable to step-up DC-DC input voltage into multiple range of output that supply by the DC power supply

ii. Apply the LED power saving at boost converter output to prove economical power consumption

iii. Compare the complexity of voltage multiplier and boost converter as the source of LED power saving

1.5 Scope of Project

In this project, I want to build a boost converter which will interface with the PIC controller that controls the driver circuit that generate the pulse for the boost converter. There are specifications that need to consider for the boost converter such as:

Voltage multiplier Input	: 240 VAC
Voltage multiplier Output	: 9VDC, 15VDC, 24VDC, 105VDC
Boost converter input voltage	: 15V
Boost converter output voltage	: 28VDC-30VDC
LED power supply source	: 12VDC

1.6 Summary of the Project

The flow of the project can be summarized by the block diagram and flow chart respectively from figure 1.41 and figure 1.42. Both of the diagram and chart can summarize all the work progress that has been implemented in first and second semester.

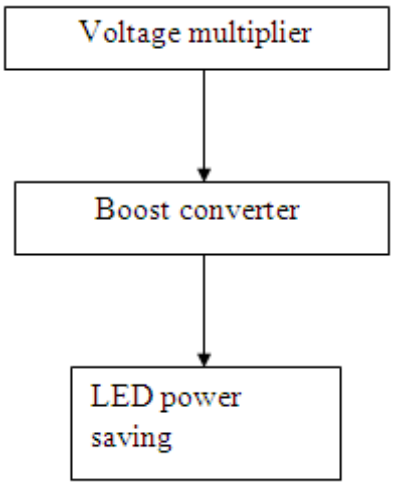

Figure 1.6: The block diagram

Description:

Boost converter circuit was sketched based on the basic boost converter circuit. Boost converter part and component has been studied and identified. At first the boost converter specification are listed to ensure the required calculation for the component such as inductor, capacitor and resistor value. It is important especially for the inductor since the value for inductor cannot be found in the market; it has to be made by using conventional way.

The circuit has been designed in the PSPICE to ensure that the result of the boost converter certified with the output voltage specification. It is important to know whether the boost converter successfully step-up the voltage to the calculation value of output voltage.

The voltage regulator are needed to get desired voltage regulated from the source voltage for the boost converter while the capacitor are needed as the filters to get clean Vdc output for any lamp or other applications.

Description:

The voltage multipliers are use in this project as the source for the boost converter and other application even for the LED power saving and motor. The